UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/856,211	05/18/2001	Vincent Derycke	33585	6755

116 7590 03/23/2004

PEARNE & GORDON LLP
1801 EAST 9TH STREET
SUITE 1200
CLEVELAND, OH 44114-3108

EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 03/23/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/856,211	DERYCKE ET AL.	
	Examiner	Art Unit	
	Matthew J Song	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 December 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 and 4-14* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1 and 4-14* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 12/29/2003 has been entered.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 1 and 5 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter, which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 1 recites, " said layer of diamond-type carbon thereby extending over substantially the entire area of said substrate and being formed **without** alternate heating and cooling of said substrate by intermittently passing an electric current therethrough for less than a second" in the last five lines, which is a negative limitation. Any negative limitation or exclusionary proviso must have basis in the original disclosure and the mere absence of a

positive recitation is not basis for an exclusion (MPEP 2173.05 (i)). The instant specification does not provide a positive recitation of the basis for the negative limitation, likewise for claim 5.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 1 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yoder (US 5,225,366) in view of Dreifus et al (US 5,420,443).

Yoder discloses atomic layer epitaxy of single crystalline diamond thin films by exposing a plurality of diamond like substrates to a halocarbon reactant gas and a hydrocarbon reactant gas at substrate temperatures between 300°C and 650°C and the time to grow an individual atom

layer is $25x10^{-6}$ seconds (abstract and example 1). Yoder also discloses single crystalline substrates having lattice constants closely matched to that of diamond can be used, such as copper for single crystalline diamond growth (col 9, ln 20-45). Yoder also discloses 100% nucleation coverage, this reads on applicants extends closely over the totality of the substrate and layer of diamond-type carbon thereby extending over substantially the entire area of the substrate (col 4, ln 50-65).

Yoder discloses a substrate having a lattice constant matched to that of diamond can be used. Yoder does not disclose a SiC substrate.

In a method of fabricating microelectronic structures having diamond structure on a nondiamond structure, Dreifus et al teaches a highly oriented diamond film formed on a non-diamond substrate and the substrate may be a single crystal substrate of a material having a relatively close lattice match to diamond, such as β-SiC or copper which supports diamond growth, where lattice match refers to the difference between the lattice constant of diamond and SiC (col 10, ln30-50 and col 15, ln 15-45).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Yoder with Dreifus et al's SiC substrate because SiC has a close lattice match promoting single crystal growth.

The combination of Yoder and Dreifus et al is silent to alternate heating and cooling of the substrate by intermittently passing an electric current therethrough for less than a second, this absence of teaching this limitation reads on applicants without alternate heating and cooling.

Referring to claim 1, the combination of Yoder and Dreifus et al does not teach the layer of diamond-type carbon being **formed by** transformation of the carbon hybridization on the last

atomic layer of the SiC substrate, this is a product-by process claim. The patentability determination of a product-by-process claim is based on the patentability of the product and does not depend on its method of production (MPEP 2113) and the combination of Yoder and Dreifus et al teaches of the product limitations, as discussed previously.

6. Claims 1, 4-6 and 8-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Powers et al (The American Physical Society, Physical Review 1991, Structural analysis of the β-SiC (100)-c(2x2) surface reconstruction by automated tensor low-energy electron diffraction) in view of Liu et al (US 5,516,500).

Powers et al discloses a β-SiC (100) surface terminating in a layer of silicon atoms (col 1) and two different routes to prepare a c(2x2) surface reconstruction, where the first method required a removal of surface silicon from a (2x1) surface by high temperature annealing in UHV and at approximately 1300 K, the (2x1) to c(2x2) conversion required 10-15 minutes of annealing (col 5). Powers et al also discloses an ordered c(2x2) surface could be produced by exposure of a (2x1) surface at 1125 K to 100L C_2H_4 (col 6), where a C terminated surface, that is terminated by an atomic plane of carbon of sp configuration is inherently obtained because Powers teaches a similar method of forming a c (2x2) surface as applicant. Powers et al also discloses the c(2x2) surface terminates with a staggered array of C_2 groups in silicon bridge sites (col 10) and the surface carbons are sp^2 hybridized (col 8).

Powers et al is silent to an annealing of the substrate to transform the place of carbon-carbon dimmers into a plane of carbon-carbon dimmers of sp^3 configuration.

In a method of forming diamond materials by rapid heating of carbon containing materials, Lui et al teaches a carbon material is disposed between two electrodes and the temperature of the carbon containing material is elevated by at least 1000°C (col 4, ln 15-30 and claim 3). Lui et al also teaches a duration and number of iterations required to effect a synthesis of a diamond material from a carbon containing material may be empirically determined (col 4, ln 35-55). Lui et al also discloses the diamond phase is thermodynamically stable and has an sp^3 configuration (col 1, ln 25-30 and col 2, ln 50-60). Lui et al also discloses a coating of the surface of a substrate with a thick or thin film diamond material is useful on a cutting tool insert (col 2, ln 45-60 and col 5, ln 15-30).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Powers et al with Lui et al's rapid heating to form a film of diamond because a diamond film is useful on a cutting tool insert.

The combination of Powers et al and Lui et al is silent to the diamond film is a monoatomic layer. It is inherent to the combination of Powers et al and Lui et al to form a monoatomic layer because the combination of Powers et al and Lui et al teaches a similar substrate as applicant, which is annealed as taught by applicant.

Referring to claim 1, the combination of Powers et al and Lui et al does not teach without alternate heating and cooling of the substrate by intermittently passing an electric current therethrough for less than a second. The combination of Powers et al and Lui et al teaches the high-amperage current need be applied only for a short time interval, such as less than a second ('500 col 4, ln 25-30) and the time required to effect the synthesis of a diamond material may be empirically determined ('500 col 4, ln 45-51), which is a teaching that the time is a result

effective variable. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Powers et al and Lui et al by optimizing the time to be greater than one second to ensure diamond synthesis by conducting routine experimentation of a result effective variable (MPEP 2144.05).

Referring to claims 1 and 4, the combination of Powers et al and Lui et al teaches a β-SiC on a Si wafer, this reads on applicant's platelet, and annealing a substrate to form a thick film of diamond for a desired number of iterations.

Referring to claim 5, the combination of Powers et al and Lui et al teaches a SiC c(2x2) substrate and annealing to form a single crystalline diamond film.

Referring to claim 6, the combination of Powers et al and Lui et al teaches a SiC substrate with a face terminated by a layer of Si.

Referring to claim 8, the combination of Powers et al and Lui et al teaches annealing at 1300°K.

Referring to claim 9-10, the combination of Powers et al and Lui et al teaches exposing a substrate to C_2H_4.

Referring to claim 11, the combination of Powers et al and Lui et al teaches a temperature of greater than 1000°C, this reads on applicant's 1250°C, if it does not read on applicant's 1250°C then it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Powers et al and Lui et al by optimizing the temperature by conducting routine experimentation because temperature is a result effective variable. The combination of Powers et al and Lui et al is silent to the annealing time being greater than or about equal to 25 minutes. The combination of Powers et al and Lui et al teaches the number of

iterations and duration can be empirically determined to synthesis materials. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination Powers et al and Lui et al by optimizing the annealing time by conducting routine experimentation because time is a result effective variable.

7. Claims 7 and 12-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Powers et al (The American Physical Society, Physical Review 1991, Structural analysis of the β-SiC (100)-c(2x2) surface reconstruction by automated tensor low-energy electron diffraction) in view of Liu et al (US 5,516,500) as applied to claim 5 above, and further in view of Kackell et al (Diamond and Related Materials 6 (1997) pg 1346-1348, Polytypism and surface structure of SiC).

The combination of Powers et al and Lui et al teaches all of the limitations of claim 7, as discussed previously, except the substrate is a SiC platelet in hexagonal phase with a face terminated by a layer of Si.

In a teaching of the surface structure of SiC, Kackell et al teaches Si-terminated SiC (111) is qualitatively equivalent to Si-terminated 2H SiC(0001) (col 1 and 3).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Powers et al and Lui et al with Kackell et al because cubic and hexagonal SiC are taught to be equivalents. (MPEP 2144.06)

Referring to claim 7, the combination of Powers et al, Lui et al and Kackell et al teaches a hexagonal SiC substrate.

Referring to claim 8, the combination of Powers et al, Lui et al and Kackell et al teaches annealing at 1300°K.

Referring to claim 13-14, the combination of Powers et al, Lui et al and Kackell et al teaches exposing a substrate to C_2H_4.

Response to Arguments

8. Applicant's arguments with respect to claims 1-15 have been considered but are moot in view of the new ground(s) of rejection.

The arguments directed to the combination of Powers et al and Lui et al are not persuasive based on the new grounds of rejection.

9. Applicant's arguments filed 12/29/2003 have been fully considered but they are not persuasive.

Applicant's argument that the prior art teachings related to nucleation and growth, not the phenomenon of the invention based upon the transformation of the carbon hybridization on the last atomic layer of a specially prepared SiC substrate is noted but is not found persuasive. The argument is directed to the method of preparation. The Examiner maintains the product claimed is taught by the combination of Yoder and Dreifus, as discussed previously.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Dreifus is relied upon solely as a

teaching of a substrate used for diamond growth. Yoder teaches the monoatomic and monocrystalline diamond deposition. Therefore, the 3D germenation taught by Dreifus is not incorporated in the rejection.

Applicants' argument that Yoder does not teach a monoatomic layer is noted but is not found persuasive. The Examiner maintains that the Atomic layer epitaxy (ALE) taught by Yoder by definition forms an atomic layer. Also, Yoder teaches the reactions are self-limiting and exactly one atomic layer of carbon is grown (col 11, ln 60-67 and col 12, ln 35-40). Therefore, Yoder does teach forming one atomic layer of carbon.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Dreifus is relied upon solely as a teaching of a substrate used for diamond growth. Yoder teaches the monoatomic and monocrystalline diamond deposition. Dreifus is not relied upon as a teaching of forming a monocrystalline diamond and monocrystalline layer, as suggested by applicants (page 9-10).

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). The Examiner admitted in the rejection that Powers et al does not teach sp^3 carbon. Liu et al teach this feature, Powers is relied upon as a teaching of a SiC substrate with a Carbon terminated surface.

Applicants' argument that the process of the present invention does not require a cooling step is noted (page 12) but is not found persuasive. Liu et al teaches a process heating carbon to form diamond, which comprises heating and cooling. The instantly claimed invention obtains diamond by heating. The instant specification teaches forming a monoatomic and monocrystalline layer by annealing, note page 3, which is taught by Liu et al; therefore the combination of Powers et al and Liu et al does teach annealing, which inherently would produce a monoatomic and monocrystalline layer. The instant specification does not teach cooling is detrimental. Furthermore, the cooling occurs after annealing; therefore the intermediate product formed directly after annealing would inherently have the properties claimed by applicants.

Conclusion

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song
Examiner
Art Unit 1765

MJS

NADINE G. NORTON
SUPERVISORY PATENT EXAMINER